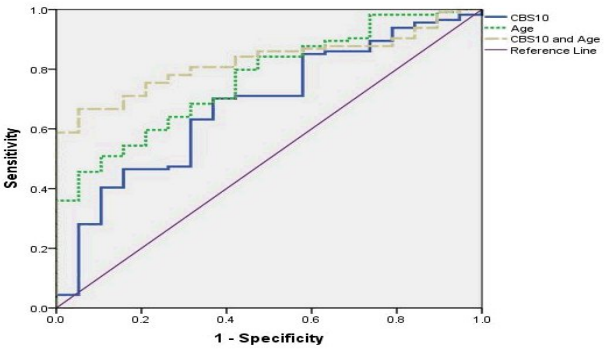
$$PLuRa = \frac{|y|}{y}\left(e^{|y|}-1\right),\ y = k_0 + k_{age}\cdot age + k_{CBS}\cdot CBS$$

Parameter	Value	p	Effect size	Spearman's rank	
				R	p
10th fraction model				0.35	<0.001
k_0	-0.80 (-1.48;-0.13)	0.022			
k_{age}	0.021 (0.011;0.031)	<0.001	0.42 (0.11;1.26)		
k_{CBS}	3.53 (0.27;6.80)	0.036	0.20 (0.01;0.45)		
20th fraction model				0.35	<0.001
k_0	-0.76 (-1.43;-0.09)	0.028			
k_{age}	0.020 (0.010;0.030)	<0.001	0.40 (0.10;1.22)		
k_{CBS}	3.46 (0.41;6.50)	0.028	0.21 (0.02;0.47)		
30th fraction model				0.39	<0.001
k_0	-0.74 (-1.40;-0.09)	0.028			
k_{age}	0.019 (0.010;0.029)	<0.001	0.38 (0.09;1.17)		
k_{CBS}	3.12 (0.074;5.10)	0.003	0.30 (0.09;0.57)		

PLuRa is the predicted lung radioresponsiveness and has the units of [HU/Gy]. The effect size is defined as the change in PLuRa when changing a parameter from the median value to the median value plus one standard deviation of the parameter, while keeping all other parameters fixed and has the units of [HU/Gy]. k_{age} has units of [year^{-1}]. The other parameters are unitless. The standard deviation of the age is 8.6 years and the standard deviation of the CBS values are 0.026, 0.028, and 0.042 for 10th, 20th, and 30th fraction, respectively.



Conclusions: This study indicates that the effect of radiation dose on the local lung damage may be partially detected already during RT using CBCT image analysis. If a high LuRa value is shown to be a good surrogate endpoint for clinical toxicity and the results of the current investigational study are validated, the proposed response models may provide an assay for identifying a subgroup of low-responsive patients as potential candidates for safe dose escalation.

Symposium: Treatment planning improvements

SP-0626
The promise of functional volume automatic segmentation

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Accurate, robust, reproducible and fast delineation of functional tumor volumes in 3D using positron emission tomography (PET) has been already identified as a pressing challenge for an increasing number of oncology applications, such as image-guided radiotherapy, as well as diagnosis, prognosis and therapy response assessment. The main drive behind this interest is based on the fact that the use of functional imaging allows the biological characterization of active tumor volumes employing different tracers. There is therefore a growing need for accurate quantification of both tumor volume and associated indices of tracer accumulation, such as standardized uptake values, in order to refine detection criteria associated with various forms of cancer and study the relationship between overall tumor burden and response to therapy or survival. Following the introduction of the main clinical incentives behind the development of functional volume segmentation algorithms, the objectives of this presentation will be to (a). provide a critical analysis of the currently available segmentation methods and associated validation studies, (b). provide guidelines with respect to the clinical use of existing semi-automatic and fully-automatic algorithms, (c). discuss the impact of automatic functional segmentation algorithms within the context of therapy response monitoring and radiotherapy treatment planning.

SP-0627
Online therapy refinement and reoptimisation of treatment plans

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Temporal changes of the location and shape of tumour targets or organs at risk during a course of treatment are considered one of the major obstacles to deliver high precision radiation therapy (RT) for a number of treatment sites. According to the different time scales on which these organ movements and deformations are expected to occur one differentiates between inter- and intra-fraction organ motions. One basic strategy to account for the effect of anatomical changes during RT refers to treatment plan adaptation that can be either achieved as the refinement of an existing treatment plan or as complete re-optimisation of treatment parameters for the new patient geometry. The standard scenario envisioned for a clinical workflow is based on a set of 3d-images of the patient in treatment position directly prior to treatment acquired either by in-room imaging devices, ranging from in-room kV-CT, MV-CBCT, kV-CBCT or MV-CT to MRI. These images are then prepared for either treatment plan modification or re-planning by fast image processing that identifies the actual volumes of interest relevant for autmatic plan optimisation. These methods were originally designed for off-line modifications of established treatment plans to account for slowly developing anatomical changes like weight loss/gain of patients or radiation induced tissue responses. However, improved soft tissue contrast, especially achievable with MRI combined with ultra-fast treatment planning tools will allow to extend the application of this treatment adaptation strategy to the on-line regime, i.e., either directly prior to treatment or even during treatment. We will discuss the development and application of on-line treatment plan adaptation tools for inter- and intra-fraction changes of the patient anatomy. Starting point will be a dynamic patient model (DPM) which will be continously up-dated through images acquired during the course of treatment. The DPM can be used to re-construct the delivered dose to the patient, before a new treatment plan is established. This second step can be either achieved by interactive refinement of an existing treatment plan via a graphical interface or by a complete re-optimisation. Both approaches require a different approach of online quality assurance. Furthermore, we will discuss the scenario of an online feedback loop between real-time plan adaptation and dynamic dose delivery concepts.

SP-0628
Knowledge based: new planning perspectives

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Intensity modulated treatments, in the two forms or IMRT with fixed fields and VMAT (volumetric modulated arc therapy) with rotational approach, is possible only thanks to the inverse process for planning the treatments. This opens the challenge to translate the desired dose distributions, including the broad knowledges on the toxicity dose levels for the critical structures, into the proper dose-volume